Title: Motion Magic

Brief Overview:

In this unit students will work with the concepts and formula for velocity. Students will be introduced to the concept of motion in both mathematical representations and, using the TI-83 graphing calculators, graphical representations. Students will than complete a lab and other activities dealing with rate, time, and distance.

Links to NCTM Standards:

- **Mathematics as Problem Solving**
  Students will solve a real-world problem.

- **Mathematics as Communication**
  Students will use math to communicate ideas about issues effecting school and community safety and environment

- **Measurement**
  Students will use a variety of measurements tools to complete this activity. Students will measure distances and time to solve problems

- **Patterns and Functions**
  Students will analyze real-world occurrences using graphical representations

Links to Science Standards:

- **Physical Science**
  Students will discover that an object's motion can be described and represented graphically according to its position, direction of motion, and speed.

- **Science as Inquiry**
  Students will use appropriate tools and techniques including graphing calculators and CBL's to gather, analyze and interpret data.

Grade/Level:

This unit is intended for 8th grade students. It is recommended for use with students taking algebra and physical science

Duration/Length:

This activity is designed to be used in 55 minute blocks/periods and should take 5 days.

Prerequisite Knowledge:

Students should have a working knowledge of the following:

- Collecting and organizing data
- Converting of standard units of measure
- Using a stop watch

- Using basic functions (such as lists and graphing) of the TI-83 (or TI-82) calculator. Students will be asked to input data into lists and generate graphs based on collected data. Some review of this procedure has been included in the unit, but the expectation is that students have used graphing calculators before.
- Recognizing and applying basic formulas

Objectives:

Students will be able to:

- accurately use the formula $R=D/T$ to calculate any variable not given.
- explain motion using graphical representation.
- solve problems by collecting and analyzing time/distance data.

Materials/Resources

- TI-83 Calculators (one per student if possible. If not, one per team)
- CBL with motion sensor (one for teacher demonstration)
- Stop watches (one per team)
- Overhead projector with LCD panel with patch cord for TI-83
- Meter Sticks/Trundle wheel
- Student worksheets

Development/Procedures

Note: If there are not enough calculators for each student, introductory activities may be completed in teams depending on number of calculators available.

Day 1:

Teacher will use CBL with motion sensor and overhead LCD panel. Have a student volunteer to walk at constant velocity away from the sensor to show students a graphical representation of forward, constant speed. Have students use Worksheet #1 to record the results of the demonstration. Discuss with students the meaning of the graphical representation.

Now focus student attention on Example #1 on the worksheet. Have students discuss and predict the meaning of each part of the graph. Have students fill in on the example the actual movement represented on the graph.

Next, give students two descriptions of different motions. Have students predict what each motion would look like on a graph. Use the *Students Prediction* portion of the worksheet to have students record their predictions. Demonstrate each example of motion using the CBL and graphic calculator and have students record the actual graphical representation. Discuss each example with students.

Day 2:

Return to Demonstration #1 from yesterday's worksheet to focus students attention on the meaning of the graphs. Students should be shown the formula S=D/T. Use the graph example to define constant speed. Constant speed is defined as an average value for a given time interval.

Distribute Worksheet #2 and have students complete worksheet. Check answers with students.

Day 3:

NOTE: This is where an understanding of the advanced functions of the TI-83/TI-82 calculators is essential. Make sure you are familiar with the step by step instructions for entering data and graphing the results before you try this with students

Demonstrate for students how to enter time/distance information into the TI-83 List feature. Use the LCD overhead display, or have students follow along with calculators as you enter in the data from Worksheet #2. Have students compare the results shown on the TI-83 with the results they got from hand drawn graphs. Have students discuss the differences and advantages and disadvantages for each method.

Day 4 - Day 6:

Distribute the handout Speed Trap. Review this activity carefully with students. There are a number of steps that need to be completed outside. Make sure you remind students about safety procedures when working near a road. After students have made their measurements outside and collected their data, bring them back inside to complete the activity. Students should work in teams when collecting data and may work either in teams or independently to complete the other parts of the activity.

Performance Assessment:

The performance assessment for this unit will be a work sheet activity where students will describe motion based on graphical representation and will answer questions pertaining to the formula used and measurements recorded in the unit. In addition teacher will use the writing prompt to assess student understanding of basic concepts covered during the task *Speed Trap*.

Extension/Follow-Up:

- Have students interview, or bring in to speak to the class, someone from the department of transportation or city hall to discuss what goes into determining traffic patters.
- Invite someone in from the insurance industry to speak about the connection between speeding, accidents, and insurance rates.
- Invite a member of the local police department to speak to the class and demonstrate radar and laser guns.
- Have students plan a trip using maps and/or the Internet (www.yahoo.com/maps) estimate daily mileage based on highway speed limits.

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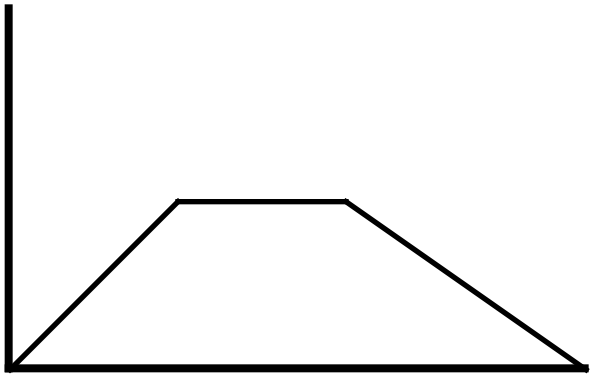
Motion Magic Work Sheet #1

Name: _____ Date: _____ Class: _____

Demonstration #1

Example #1



Students Prediction

#1

#2

Actual Results

#1

#2

Motion Magic Worksheet #2

Name: _____ Date: _____ Class: _____

In this activity you will be using the TI-83 graphing calculator to complete two different types of problems. Today we will look at a road trip your teacher took this past summer. Your task is to compute the average speeds for each part of the trip **and** to complete a graph showing the speeds for the day.Use your calculator to help you.

Complete ALL the blanks on this chart. Remember the formula for finding average speed.

Time of day	Elapsed Time	Destination	Miles Traveled	Average Speed
6:00 am - 7:00 am		Baltimore - Perryville, MD	62	
7:00 am - 8:00 am		Stayed in Perryville for shopping and breakfast	0	
8:00 am - 9:30 am		Perryville, MD - Philadelphia, PA	85	
9:30 am - 10:30 am		Caught in traffic in Philadelphia	15	
10:30 am - 12:00 pm		Philadelphia, PA - New York City, NY	110	

Now, Let's take a look at your answers. Using what you worked out about my trip to New York, construct a graph showing the average speeds over the whole day. Remember TAILS: TITLE, AXIS, INCREMENTS, LABEL & SPACING.

1) What was the average speed for the whole trip? _____

2) The average speed on Interstate 95 is 65 miles per hour. Was there a point when my average speed was above the posted speed limit? _____ If so, when? _____

_____

Motion Magic Worksheet #2 Answer Key

Name: _____ Date: _____ Class: _____

In this activity you will be using the TI-83 graphing calculator to complete two different types of problems. Today we will look at a road trip your teacher took this past summer. Your task is to compute the average speeds for each part of the trip **and** to complete a graph showing the speeds for the day.Use your calculator to help you.

Complete ALL the blanks on this chart. Remember the formula for finding average speed.

Time of day	Elapsed Time	Destination	Miles Traveled	Average Speed
6:00 am - 7:00 am	1 hour	Baltimore - Perryville, MD	62	62 mph
7:00 am - 8:00 am	1 hour	Stayed in Perryville for shopping and breakfast	0	0 mph
8:00 am - 9:30 am	1.5 hours	Perryville, MD - Philadelphia, PA	85	56.7 mph
9:30 am - 10:30 am	1 hour	Caught in traffic in Philadelphia	15	15 mph
10:30 am - 12:00 pm	1.5 hours	Philadelphia, PA - New York City, NY	110	73.3 mph

Now, Let's take a look at your answers. Using what you worked out about my trip to New York, construct a graph showing the average speeds over the whole day. Remember TAILS: TITLE, AXIS, INCREMENTS, LABEL & SPACING.

1) What was the average speed for the whole trip? _____45.3 mph_____

2) The average speed on Interstate 95 is 65 miles per hour. Was there a point when my average speed was above the posted speed limit? __yes____ If so, when? ___Between Philadelphia and NYC _____

SPEEDTRAP

Parents who live in the neighborhood around your school have expressed concern about the traffic that passes on the street in front of your school. Some parents claim to have seen cars speeding past the school, and they are concerned that this could be a hazard to the students.

During this task, you and the other members of your team will perform an experiment to determine whether cars obey the posted speed limit on the street in front of your school. For certain activities, you will need to go outside to the sidewalk next to the street in front of the school. Remember, whenever you are near the street, BE VERY CAREFUL!!

ACTIVITY 1

Streets that pass by schools are normally marked with signs to warn drivers that they are near a school, and that they should drive carefully. The speed limit on such streets is lowered during school hours so that the risk of accidents is reduced.

Step A. Working with your teacher, locate the speed limit sign nearest to your school and record the following information:

Speed Limit (during school hours) = _____

Distance from the sign to the front of the school = _____ meters

Step B. Convert the speed limit in Step A from miles per hour to kilometers per hour.

Speed Limit (during school hours) = _____

Step C. Explain how you determined your answer in Step B.

_____

_____

_____

_____

_____

ACTIVITY 2

Your team will now go outside to the street in front of the school and take data to measure the speeds of selected cars that pass by. Your teacher will tell you which cars to pick (so that all teams will be collecting data for the same vehicles). Remember, when you are outside near the street, BE VERY CAREFUL!!

Step A. To measure the speed of the cars, we will need to select two points: one where we will start timing the cars; the other where we will stop timing. Work with the entire class to select two point along the street. Measure and record the distance between the two points (to the nearest meter).

Distance Between Two Reference Points = _____

Step B. Two of your classmates will be positioned at the starting and stopping points, and will signal when to start and stop timing the cars. Your teacher will tell your team which cars are being selected for your data. You will collect data for six cars. Use the stop watch and measure the time it takes for each car to travel between the two points on the street. Use your team's graphing calculator and enter the time for each car (to the nearest tenth of a second) on a list. (NOTE: You access the lists by pressing the STAT key and then selecting EDIT from the menu.) When you are finished collecting data your team will return to the classroom.

ACTIVITY 3

Working with your team, you will now use the graphing calculator to calculate the speed for each of the six cars you collected data for in Activity 2. You will then compare your team's results to the class average.

Step A. Return to the list on the graphing calculator where you stored the time data for each car. Make a second list showing the speed for each car in meters per second. Next, knowing that 1 mile = 1600 meters, and 1 hour = 3600 seconds, make a third list showing the speed for each car in miles per hour (rounded to the nearest whole). Record the speeds from this list in the chart below.

Car	Speed
1	
2	
3	
4	
5	
6	

Step B. Working with your teacher, use the graphing calculators to find the class average for the speed of each car. Enter the average value in the chart below.

Car	Class Average for Speed
1	
2	
3	
4	
5	
6	

Step C. Did your group collect accurate data for the speeds of the six cars, as compared to the average values for the class. Justify your response.

Step D. Based on the data your class collected for the six cars, do you think there is a problem with drivers obeying the speed limit while driving in front of the school? Use evidence from the previous activities to support your conclusions.

Step E. When traffic engineers study driving habits, they collect data for thousands of vehicles. Why might it be important to collect so much data?

Scoring Sheet/Rubric For Speed Trap

Activity 1

Step A: Not scored

Step B: Not Scored

Step C: 2 Points: Students show understanding of process AND have correct conversion.

1 Point: Students show understanding of process OR have correct answers.

0 Points: Any other response

Activity 2

Step A Not Scored

Step B Not Scored

Activity 3

Step A 2 Points: Correct units AND answers given to the nearest whole

1 Point: Correct units OR answers given to the nearest whole

0 Points: Any other answer

Step B Answers will vary. Check for accuracy

Step C 1 Point: Student has clear answer. Student has compared their groups answer to that of the whole class. Student has justified answer.

0 Points: Any other answer

Step D 1 Point: Student has given answer to question and provided support from data gathered.

0 Points: Any other answer

Step E 1 point: Student includes information about sample size

0 Points: Any other answer

Name: _____ Class: _____ Date: _____

Motion Magic Worksheet Writing Activity

You have been working on activities in science that deal with average speed. You have completed a number of activities where you have calculated the average speed for a car trip and for cars traveling outside your school.

Suppose your teacher asked you to write a letter to the Mayor of your home town describing the results of your traffic study. Before you begin writing your letter, think about the original concern expressed by the parents. Think about the activity Speed Trap and whether or not it supported the parents concerns. Finally, think about what might be done by the city to address parental concerns.

Now, begin writing your letter to the Mayor of your town about the traffic in front of your school.

Writing Prompt

Points	Criteria
4	Students uses correct letter format. Student uses proper spelling and writing mechanics. Student addresses all 3 “think-abouts” listed in the prompt. Student uses supporting evidence from speed trap activates and offers suggestions to address parents concerns.
3	Student uses correct letter format, however has minor errors in spelling and mechanics. Student addresses all 3 “think-abouts” however offers incomplete supporting evidence from speed trap activities.
2	Student has several errors in spelling, mechanics and format. Student addresses two out of the 3 “think-abouts” and has only minor supporting evidence.
1	Student has fails to use correct format. Student has many errors in spelling and mechanics. Student either addresses only 1 of the “think-abouts” or offers no supporting evidence for ideas presented.
0	Any other response.